

## ABSTRACT

Detective quantum efficiency (DQE) is one of the important measures in the assessment of image quality and detector performance. Detective quantum efficiency of radiographic screen-film depends on noise power spectrum (NPS), modulation transfer function (MTF), gamma of the film and photon fluence. DQE of two types of screen-films namely Lanex Regular/T-Mat G/RA and Lanex Regular/T-Mat L/RA were determined using MTF and NPS data, separately. For calculation of gamma of the film, characteristic curves of each screen-film were used to find slope of straight part of the curves. Photon fluence was estimated using published literature. DQE of the screen-films were computed by MATLAB program for three optical densities 0.7, 1.0 and 1.4. The X-ray source was at 81 kV<sub>p</sub>. MTF of Lanex Regular/T-Mat G/RA was found to be slightly better than Lanex Regular/T-Mat L/RA for spatial frequencies between 0.5 and 3.0 cycles/mm, but it was found to be slightly better MTF for Lanex Regular/T-Mat L/RA for spatial frequencies between 5.2 and 7.0 cycles/mm. NPS of Lanex Regular/T-Mat G/RA was found one and a half times bigger than Lanex Regular/T-Mat L/RA. DQE comparison of these two types of screen-films was made. The results show Lanex Regular/T-Mat G/RA has better DQE than Lanex Regular/T-Mat L/RA, at low frequencies.

## **ABSTRAK**

Kecekapan kuantum detektif (DQE) adalah salah satu ukuran yang penting dalam penilaian kualiti imej dan prestasi pengesan. Kecekapan kuantum detektif skrin-filem radiografi bergantung pada spektrum kuasa hingar (NPS), fungsi pemindahan modulasi (MTF), gama bagi filem dan fluens foton. DQE dua jenis skrin-filem iaitu Lanex Regular/T-Mat G/RA dan Lanex Regular/T-Mat L/RA ditentukan menggunakan data MTF dan NPS, secara berasingan. Untuk perhitungan gama filem, lengkung cirian setiap skrin-filem digunakan untuk mencari cerun bahagian lengkung yang lurus lengkung. Fluens foton dianggarkan daripada literatur yang diterbitkan. DQE skrin-filem dikira oleh program MATLAB untuk tiga ketumpatan optik 0.7, 1.0 dan 1.4. Sumber sinar-X adalah pada 81 kV<sub>p</sub>. MTF Lanex Regular/T-Mat G/RA ditemui bernilai sedikit lebih tinggi daripada Lanex Regular/T-Mat L/RA untuk frekuensi ruang antara 0.5 dan 3.0 kitaran/mm, tapi MTF didapati sedikit lebih tinggi untuk Lanex Regular/T-Mat L/RA bagi frekuensi ruang antara 5.2 dan 7.0 kitaran/mm. NPS Lanex Regular/T-Mat G/RA didapati bernilai satu setengah kali lebih besar daripada Lanex Regular/T-Mat L/RA. Perbandingan DQE kedua-dua jenis skrin-filem dibuat. Keputusan kajian menunjukkan Lanex Regular/T-Mat G/RA lebih tinggi DQEnya dari pada Lanex Regular/T-Mat L/RA, terutama pada frekuensi rendah.

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## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 Diagnostic Imaging**

Over the last 50 years, diagnostic imaging has grown from a state of infancy to a high level of maturity. By the discovery of X-rays by W. C. Rontgen in 1895, medical imaging has contributed significantly to progress in medicine (Doi, 2006).

Diagnostic imaging is widely used every year. There are many imaging techniques available to patients, such as, radiography, radionuclide imaging, ultrasound imaging systems, computed tomography (CT), magnetic resonance imaging (MRI) and digital radiography. Diagnostic imaging enables specialists to see the inside of the human body and is less invasive than surgery.

In medical imaging, to make better images there are some measures such as detective quantum efficiency (DQE) and noise equivalent quanta (NEQ) that are used to evaluate the image quality of each imaging system. The DQE mostly depends on noise power spectra (NPS) and modulation transfer function (MTF).

## 1.2 Screen-Film Radiography

In screen-film radiography, the X-rays are emitted from the X-ray source into the patient body, and under the patient body, a screen-film detector records the attenuated X-ray distribution. In fact, the film is sandwiched between two screens.

Before the screen was invented, the X-rays were directly detected by a radiographic film (without screens), but this is a very inefficient way to create a radiograph. Only 1 to 2 percent of the X-rays are stopped by the film, so creating radiographs by direct film exposure would require an unnecessarily large X-ray dose to the patient. To greatly improve their efficiency, modern diagnostic X-ray units always have intensifying screens on both sides of the radiographic film. The intensifying screens stop most of X-rays and convert them to light, which then exposes the film. This is a very efficient system, known as screen-film system (Prince and Links, 2006). The properties of screen-film combinations for radiographs set a lower limit for the X-ray exposure of the patient and an upper limit for the quality of the X-ray picture (Bronder and Heinze-Assmann, 1988). Figure 1.1 shows a typical commercial film with a typical screen.



**Figure 1.1** Typical boxes of films (left) with screens (right) (Kodak Company)

### **1.3 Problem Statement**

Diagnostic radiology is related mostly with image quality, which is the big challenge for specialists to improve. Better image quality results in better diagnosis. Manufacturing screen-films with higher DQE to get better image quality is the main concern in medical imaging. MTF and NPS have important role to improve the DQE to create more contrast and less noise.

### **1.4 Research Objectives**

The aim of this work is

- 1) To study theoretically about parameters that affect DQE.
- 2) To find out how each parameter must be calculated.
- 3) To determine the MTF and NPS for the spatial frequencies which are not included in data using interpolation techniques.
- 4) To calculate the DQE and make comparison of DQEs for each screen-film to find out which screen film has better image quality and performance.

## **1.5 Scope of Research**

Calculation of DQE will be limited to two types of screen-films namely Lanex Regular/T-Mat G/RA and Lanex Regular/T-Mat L/RA. DQE will be determined for three optical densities 0.7, 1.0 and 1.4 for each screen-film. Radiation Source is X-ray from machine operated at 81 kV<sub>p</sub>.

## **1.6 Significance of Study**

Importance of image quality in radiography results in wide range of investigations about finding suitable screen-films for imaging purposes. This work will give information about DQE of each screen-film to find out which type of screen-film has better image quality with respect to DQEs, MTF and NPS.

## **1.7 Thesis Outline**

The thesis is arranged into 5 chapters. Chapter 1 includes research background of the work and objectives of this work. Chapter 2 contains literature review of related parameters which affect the DQE. Chapter 3 is about calculation methods of screen-film systems. Chapter 4 gives results and findings of this work. Conclusion and future work are expressed in Chapter 5.